



Designation: D 2533 – 99

An American National Standard

Standard Test Method for Vapor-Liquid Ratio of Spark-Ignition Engine Fuels¹

This standard is issued under the fixed designation D 2533; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers a procedure for measuring the volume of vapor formed at atmospheric pressure from a given volume of gasoline. The ratio of these volumes is expressed as the vapor-liquid (V/L) ratio of the gasoline at the temperature of the test.

1.2 Dry glycerol can be used as the containing liquid for nonoxygenated fuels.

1.3 Mercury can be used as the containing liquid with both oxygenated and nonoxygenated fuels. Because oxygenates in fuels may be partially soluble in glycerol, gasoline-oxygenate blends must be tested using mercury as the containing fluid.

NOTE 1—Test Method D 4815 can be used to determine the presence of oxygenates in fuels.²

1.4 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 7 and Note 11.

2. Referenced Documents

2.1 ASTM Standards:

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products³

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.08 on Volatility.

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In 1967, this method was adopted as standard without revision.

² Test Method D 5188 is applicable to both gasoline and gasoline-oxygenate blends for measuring this property and does not require the use of mercury.

³ Annual Book of ASTM Standards, Vol 05.02.

D 4815 Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C₁ to C₄ Alcohols in Gasoline by Gas Chromatography³

D 5188 Test Method for Vapor-Liquid Ratio Temperature Determination of Fuels (Evacuated Chamber Method)³

E 1 Specification for ASTM Thermometers⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 $T_{(V/L=20)}$, n —the equilibrium temperature at which the partial pressure of a sample under test conditions is equal to 101.3 kPa (14.69 psia) and the vapor-liquid ratio is 20.

3.1.2 *vapor-liquid ratio of a fuel*, n —the ratio, at a specified temperature and pressure, of the volume of vapor in equilibrium with liquid to the volume of liquid sample charged, at 0°C (32°F).

NOTE 2—This ratio differs from the absolute vapor-liquid ratio because corrections are not made for (1) liquid sample expansion with increasing temperature, (2) decrease in liquid sample volume by vaporization, and (3) dissolved air in the liquid sample.

4. Summary of Test Method⁵

4.1 A measured volume of liquid fuel at 32 to 40°F (0 to 4°C) is introduced through a rubber septum into a glycerol or mercury filled buret. The charged buret is placed in a temperature-controlled water bath. The volume of vapor in equilibrium with liquid fuel is measured as the desired temperature or temperatures and the specified pressure, usually 760 mm Hg. The vapor-liquid ratio (V/L) is then calculated.

4.2 If it is desired to know the temperature corresponding to a given V/L, the vapor-liquid ratio is determined at several temperatures and the selected pressure. The results are plotted and the temperature read at the given V/L.

⁴ Annual Book of ASTM Standards, Vol 14.03.

⁵ Another procedure for measuring the vapor-liquid ratio of gasoline, which gives equivalent results, and employing the Sunbury Vapor-Liquid Ratio Apparatus, is described in Appendix VII, p. 783, 1964 Annual Book of ASTM Standards, Part 17.

*A Summary of Changes section appears at the end of this standard.

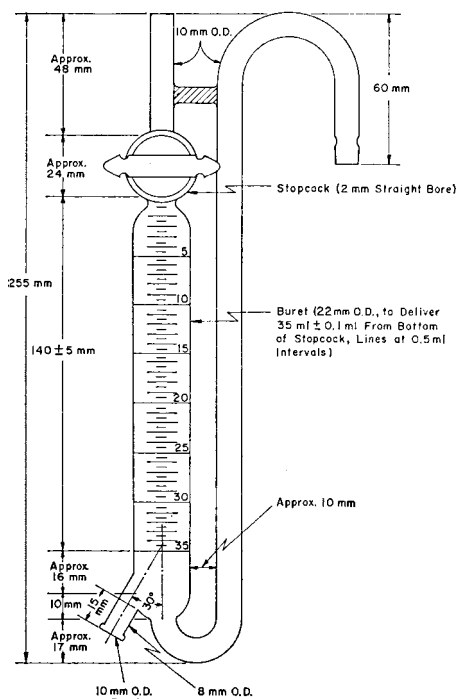


FIG. 1 Vapor-Liquid Ratio Buret

5. Significance and Use

5.1 The tendency of a fuel to vaporize in common automobile fuel systems is indicated by the vapor-liquid ratio of that fuel at conditions approximating those in critical parts of the fuel systems.

6. Apparatus

6.1 *V/L Buret*,⁶ constructed of borosilicate glass according to the dimensions shown in Fig. 1. The short bottom arm is closed with a rubber serum bottle stopper that is alcohol resistant; U.S. Army Medical Corps type.

6.2 *Pressure Control Equipment*, including the following:

6.2.1 A 250-mL leveling bulb containing dry glycerol or mercury, attached to the V/L buret by rubber tubing as shown in Fig. 2. The top of the leveling bulb must be fitted with an air-drying device. When mercury is used the drying tube must contain mercury vapor absorbent⁷ packed between balls of glass wool. This minimizes the escape of mercury vapor.

6.2.2 Means for measuring the difference in liquid level between the V/L buret and the leveling bulb. A millimetre scale for measuring the heights above a level table top is suitable for use with glycerol. A cathetometer or similar optical leveling device must be used with mercury.

6.2.3 *Barometer*, accurate to 0.5 mm Hg.

6.2.4 A mercury manometer with 1-mm divisions, required only for measurements at pressures appreciably above or below the prevailing atmospheric pressure (see Note 12). The ma-

⁶ A V/L buret and calibration stopper that have been found satisfactory for this purpose may be obtained from the Chatas Glass Co., 570 Broadlawn Terrace, Drawer H, Vineland, NJ 08360.

⁷ J. T. Baker Resisorb has been found satisfactory for this purpose.

nometer shall be connected with rubber tubing to one arm of a glass T-tube, the other arms of which shall be connected to the top of the glycerol (mercury) leveling bulb and to a stopcock or pinch clamp.

6.3 *Water Bath*, glass, at least 10.5 in. (266.7 mm) deep, stirred and thermostatically controlled, capable of being adjusted to any temperature between 90°F (3°C) and 180°F (82°C) and maintaining the water temperature within $\pm 0.2^\circ\text{F}$ (0.1°C) of the desired temperature.

6.4 *Thermometers*—ASTM Precision Thermometers having a range from 77 to 131°F and 122 to 176°F (25 to 55°C and 50 to 80°C) and conforming to the requirements for Thermometers 64F and 65F (64C and 65C) as prescribed in Specification E 1 or, for the limited ranges they cover, the ASTM Saybolt Viscosity Thermometers having a range from 94 to 108°F, 120 to 134°F, and 134 to 148°F (34 to 42°C, 49 to 57°C, and 57 to 65°C) and conforming to the requirements for Thermometers 18F, 19F, and 20F (18C, 19C, and 20C) as prescribed in Specification E 1.

NOTE 3—Digital temperature indicating devices with thermocouple, resistance, or thermistor probes are also acceptable if the system accuracy is at least 0.2°F (0.1°).

6.5 *Cooling Bath*, containing ice and water at 32 to 36°F (0 to 2°C).

6.6 *Hypodermic Syringe*, 0.5 and 1.0-mL Hamilton syringes with Chaney adaptors, fitted with a No. 20 gage, 2-in. (51-mm) needle.

6.7 *Calibration Accessories*, including an analytical balance accurate to 1 mg or better, a capillary stopcock, and weighing vials. A calibration stopper³ for the V/L buret stopcock, that is, an extra three-way solid stopcock stopper with an outlet through the end of the stopper, is convenient during calibration.

7. Reagent

7.1 *Acetone*

NOTE 4—**Warning:** Extremely Flammable.

7.2 *Chromic Acid*

NOTE 5—**Warning:** Causes severe burns. A recognized carcinogen. A strong oxidizer. Contact with organic material may cause fire.

7.3 *Glycerol*, at least 99 % pure (1 % maximum water content). Store in a dry screw-capped bottle to prevent absorption of moisture.

7.4 *Mercury*

NOTE 6—**Warning:** Poison. May be harmful or fatal if inhaled.

8. Handling of Samples

8.1 *General:*

8.1.1 Conduct bulk sampling to obtain the laboratory samples in accordance with Practice D 4057 except for gasoline-oxygenate blends where water displacement is not used. The extreme sensitivity of $T_{(V/L)}$ measurements to losses through evaporation and resulting changes in composition is such as to require utmost precaution and the most meticulous care in handling the samples.

NOTE 7—**Warning:** Extremely flammable, harmful if inhaled or ingested. Skin irritant on repeated contact. Aspiration hazard.